LEJEUNEA GRADSTEINII (LEJEUNEACEAE), A NEW LIVERWORT SPECIES FROM MT . KINABALU, SABAH

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Lejeunea gradsteinii sp. nov.
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Abstract: *Lejeunea gradsteinii* is described and illustrated as a new species from Mt. Kinabalu, Sabah. The plant stands out by 1) lobules with flat free margin and 2 teeth, the first tooth consisting of (1)-2 cells, 2) whitish-green plant color, 3) weakly crenulate margins of leaves, underleaves, female bracts and bracteoles, 4) basal cells of leaf lobes forming a weak vitta, 5) well-developed trigones and scarce intermediate thickenings, 6) deeply bifid underleaves (to 2/3) with rounded tips, 7) long male shoots with up to 13 pair of bracts, and 8) long-exserted, obovate-clavate perianths with 5 sharp keels ending into short auricles. *Lejeunea gradsteinii* is most closely related to *L. kodamae* Ikegami et Inoue and *L. bidentula* Herzog, all of which have 2-toothed lobules.

Introduction

A whitish *Lejeunea* species with two teeth on the leaf lobule, one very distinct and the other weakly developed, was found on Mt. Kinabalu, Sabah, in the course of the ongoing revision of the genus *Lejeunea* (Marchantiophyta: Lejeuneaceae) in Malaysia (Lee et al. 2011a, 2011b). By the characteristic 2-toothed, never-reduced lobule the species did not match any of the Malaysian *Lejeunea* species studied thus far, all which have lobules with only one tooth and often being reduced. A 2-toothed lobule is otherwise also known only among Asian *Lejeunea*s in *Lejeunea kodamae* Ikegami et Inoue (Inoue 1961) and *L. bidentula* Herzog (Herzog 1930), and in some members of *Papillolejeunea* Pócs (see below). However, none of these matched the species from Mt Kinabalu.

Other characteristic features of the species from Mt Kinabalu were the deeply bifid underleaves with rounded tips and, especially, the long first tooth of the lobule (2 cells long). By the latter character the species resembled the genus

Papillolejeunea Pócs (Pócs 1997; this genus was reduced by Schuster 1998 to a subgenus of *Lejeunea* [as *Lejeunea* subg. *Papillolejeunea* (Pócs) Schust.]). In his treatment of *Papillolejeunea*, Pócs (1997:1), he mentioned, "The striking feature of the plant [*Papillolejeunea*] is the special development of first (distal) lobule tooth, which is papilliform, elongate, with blunt apex, consisting of two cells and standing perpendicular to the free lobe margin which is usually involuted with the blunt second (proximal) tooth." However, the plant from Mt. Kinabalu differed essentially by the flat free margin of the leaf lobule, which was not involuted with the second tooth.

Since none of the described species of *Lejeunea* match our plant from Mt. Kinabalu, it is described here as a new species. The species is named in the honor of Prof. Dr. S. Robbert Gradstein, who is the expert of the Lejeuneaceae family and has encouraged our study of the genus *Lejeunea* in Malaysia.

Description

Lejeunea gradsteinii G.E. Lee, A. Damanhuri & A. Latiff **sp. nov.** (Figs. 1,2)

Planta dioica, lobuli bidentati, amphigastria usque ad 2/3 bifida lobis obtusis.

Type: Malaysia, Sabah, Mt. Kinabalu, trail from Mempening shelter to Layang-Layang staff quarters, montane forest, on tree trunk, 2500-2800 m alt., 12 November 2010, *G.E. Lee 1891* (holotype, UKMB; isotype, PC). Ibid., *G.E. Lee 1884, 1885, 1886, 1887, 1888, 1889, 1890* (paratypes, UKMB).

Plants dioicous, 1.3–1.4 mm wide, whitish green in the field, irregularly and densely branched with branches erect-spreading to spreading. **Stems** ca. 0.1 mm in diameter, ventral merophyte on the stem 2 cells wide, cross-section of the stem about 6 cells high, consisting of 7 epidermis cells with thin walls surrounding 15–17 medullary cells, epidermis cells distinctly larger than the medullary cells, epidermis cells 37.5–62.5 µm wide, medullary cells 12.5–25.0 µm wide. **Leaves** approximate to imbricate, when dried plants occasionally crispate, strongly convex, not crossing the stem, when moist leaves usually plane, erect-spreading to spreading, rarely convex. **Leaf lobes** 0.3–0.4 mm long and 0.2–0.3 mm wide (when flattened), ovate, leaf apex obtuse, leaf margin weakly crenulate, the ventral margin almost straight with the keel, weakly arched, when flattened forming an angle of 120^0–140^0 with the keel, the line of insertion J-shaped, along 10–11 lobe cells with 1 celled stylus on the uppermost cell of the insertion. **Leaf cells** round to oblong, abruptly become smaller towards the median cells (Fig. 1: O) and gradually become smaller towards the leaf margin, basal portion of cells are more or less elongate, apical cells 20–25 µm long and 12.5–17.5 µm wide, median cells 25–30 µm long and 17.5–20 µm wide, basal cells 25–42.5 µm long and 20–25 µm wide, cell walls hyaline,

trigones large, infrequently with intermediate thickenings. Cuticle rough, each cell covered by numerous minute papillae. Oil bodies not seen. **Leaf lobules** relatively large, never reduced, 0.3–0.4 mm long and 0.2–0.3 mm wide, up to 1/3 as long as the lobe, at an angle of about 90^0 to the stem, orbicular, strongly inflated along the keel, the keel curved, smooth, free margin flat (Fig. 1: N), apex obliquely truncate, with two teeth (Figs. 1: J, K, L), the first tooth conspicuous, 1–2 cells long and 2 cells wide at base, with a hyaline papilla on the proximal side, the second tooth small and indistinct, 1-celled, obtuse. **Underleaves** 0.2–0.4 mm long, 0.2–0.4 mm wide, 2 times as wide as the stem, distant, orbicular, covering 1/3 of the lobules, bilobed to 2/3 of underleaf length, tips narrowly rounded, lobes triangular, sinus broad, obtuse, U-shaped, margin weakly crenulate, attached to the stem by two large basal cells, base straight. Rhizoids hyaline in numerous loose fascicles, at the base of underleaves, secondary rhizoids disc lacking. **Androecia** terminal on short or long lateral branches, androecial shoot 0.4–0.7 (1.10) mm long, 0.3–0.4 mm wide with bracts. Male bracts in 4–13 pairs, hypostatic, lobules almost same size as the lobe, apex obtuse, free margin always flat, keels strongly inflated, arched, curved and smooth. Male bracteole 0–1, slightly smaller than the underleaf, margin crenulate, present only at the base of the androecial shoot. Antheridia 2 per bract, 70–85 µm in diameter, somewhat yellowish with a short and hyaline stalk, 40–50 µm in length. **Gynoecia** terminal on short or long branches, bracts loosely arranged with one innovation, 1-3 gynoecia in a lateral row due to repeatedly fertile innovations, leaf sequence of innovation lejeuneoid. Female bracts smaller than the leaf, erect-spreading when moist. Lobes 0.5–0.6 mm long, 0.2–0.3 mm wide, ovate to lanceolate, apex obtuse, margin weakly crenulate. Lobules 0.3–0.4 mm long, 0.1–0.2 µm wide, 1/2 the width of the lobe, 3/4 the length of the lobe, almost same length as the lobe, ovate to linear, apex acute to obtuse, keels straight, smooth, 0.1–0.2 mm long. Female bracteoles 0.4–0.5 mm long, 0.2–0.3 mm wide, 1/2 as long as the perianth length, larger than the underleaf, gradually tapering toward the base, ovate with tips acute, lobes approximate, sinus narrow, acute, almost equally bifid, 1/3 bilobed, margin weakly crenulate. Cells of the female bracts and bracteoles are almost similar throughout, without intermediate thickenings, occasionally with small trigones. Perianths 0.8–1.0 mm long, 0.5–0.6 mm wide, emergent up to 1/3 of its bract length, obovate-clavate, with 5 sharp, 0.10–0.15 mm wide keels, sometimes the keels extended above more or less as auricles, perianth with a 2–3 cells long beak, cells of the perianth at the keels mammillose, perianth base straight and without any stalk-like elongation. **Sporophyte** not seen. **Vegetative reproduction** not observed.

This new species is characterized by 1) whitish green color of the plant in the field, 2) crispate and strongly convex leaves when dried, 3) weakly crenulate margin of leaves, underleaves, female bracts and bracteoles, 4) rather large,

strongly inflated, never-reduced lobules, with conspicuously flat free margins, 5) apex of lobules with 2 teeth, 6) basal cells more or less elongate, ending abruptly towards median cells, forming a short and ill-defined vitta, 7) well-developed trigones and scarce intermediate thickenings, 8) obovate-clavate perianths with 5 sharp keels, 9) long male shoot with up to 13 pair of male bracts.

Lobule characters have been accepted as a significant character in the taxonomy of Lejeuneaceae (Evans 1902, Gradstein 1994, He 1996). The large lobules with two teeth at apex (Figs. 1: J, K, L) are the most significant characteristic of this new species. This peculiar feature as well as the deeply bifid underleaves with rounded tips and the obovate-clavate perianth with sharp keels is unique among all the Malaysian *Lejeunea*. The leaf lobules in this species is always strongly inflated, however, the free margin appeared to be always flat throughout and visible without flattening the leaf, and the erect or suberect first tooth of the lobule is usually of 2 cells long and with 2 large cells at base (Figs. 1: J, L), the tooth pointing toward leaf apex. At times, the first tooth is only 1 cell long and with 2 large cells at base (Fig. 1: K). The second tooth is not so distinct and always blunt.

On immature or weaker plants, the shoots may be only ca. 0.7–0.8 mm wide, the perianth, then, is somewhat reduced (0.6–0.8 mm long, 0.4–0.5 mm wide) and becoming obovate instead of obovate-clavate. In this situation, the perianth is only slightly emergent from its bracts (Fig. 2: g). On vigorous plant, however, the perianth is larger (0.8–1.0 mm long and 0.5–0.6 mm wide) and obovate-clavate in shape with 5 sharp keels, sometimes the keels extended above as slight auricles. The perianth is visibly emergent beyond the bracts, up to 1/3 of its length.

Lejeunea gradsteinii may be confused with *L. alata*. In both species the leaves are usually crispate when dry, long branches are very rare and perianths are somewhat clavate with five sharp keels. However, *L. gradsteinii* can be easily separated from *L. alata* by the large lobules with two teeth at apex. Superficially, *L. gradsteinii* is also similar to *L. pallide-virens*, but the latter is autoicous and its male bracteoles are present throughout the androecial shoot.

Generally, the species *Lejeunea* has inflated, well-developed lobule which the first tooth is usually 1-celled and the second tooth is usually reduced and invisible (He 1996). However, exceptionally there are two distinct teeth. The latter character is shared with genera such as *Cheilolejeunea* and *Leucolejeunea* (the latter genus has recently been reduced to synonymy under *Cheilolejeunea*; Malombe 2009, Yu et al. 2010). The first *Lejeunea* with two distinct teeth on the leaf lobule was described by Herzog (1930) from Yunnan, China, as *L. bidentula*. Subsequently, Inoue (1961) described a new species, *L. kodamae* from Japan with the same characteristic. The two species shared many features and were considered possibly conspecific (Inoue 1961). However, Mizutani (1971) revealed a number of differences between *L. bidentula* and *L. kodamae,*

including the length of the perianth beak, the number of medullary cells of the stem in cross-section, the width of the stem with leaves, the shape of the leaf lobe, and the width of underleaf. Mizutani (1971) also reported *L. bidentula* from India and Nepal. The present new species is quite different from these two taxa as is shown in Table 1.

Table 1. Morphological comparison of *L. gradsteinii*, *L. kodamae* and *L. bidentula.*

Characters	*L. gradsteinii*	*L. kodamae*	*L. bidentula*
Sexuality	dioicous	autoicous	autoicous and paroicous
Leaf size (long x wide)(mm)	0.3–0.4×0.2–0.3	0.5–0.8×0.4–0.6	0.7×0.45
Number of medullary cells of stem in cross-section	15–17	6–7	10–12
Lobes of underleaf	rounded to obtuse	acute	acute
First teeth of leaf lobules (cells long x cells wide)	1–2×1	3–4×1–2	2–3×1
Androecia (bracts)	4–13 pairs	3–6 pairs	3 pairs
Perianth shape	obovate-clavate	pyriform	pyriform
Perianth size (long x wide)(mm)	0.8–1.0×0.5–0.6	0.5–0.6×0.35–0.4	0.8–0.9×0.55–0.6
Perianth beak (cells long)	2–3	3–4	7–8
Position of perianth	emergent up to 1/3	not emergent	emergent up to 1/2

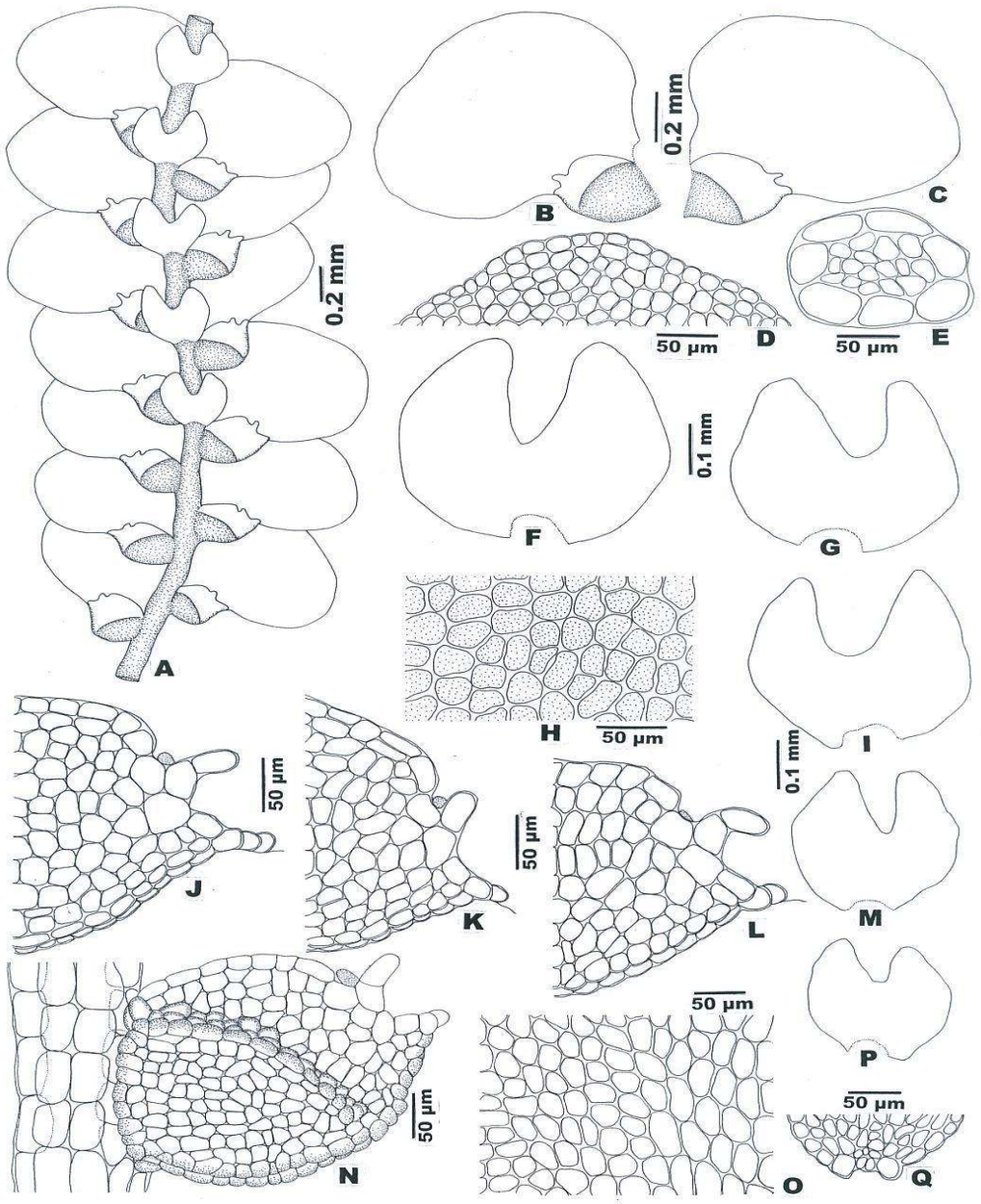

Figure 1. ***Lejeunea gradsteinii*** G.E. Lee, A. Damanhuri & A. Latiff sp. nov.: **A**: Part of plant; **B,C**: Leaves; **D**: Apical cells of leaf lobe; **E**: Cross section of stem; **F,G,I,M,P**: Underleaves; **H**: Median cells of leaf lobe; **J,K,L**: Lobule apices; **N:** Leaf lobule; **O**: Basal cells of leaf lobe; **Q**: Basal cells of underleaf. (All from holotype G.E. Lee 1891).

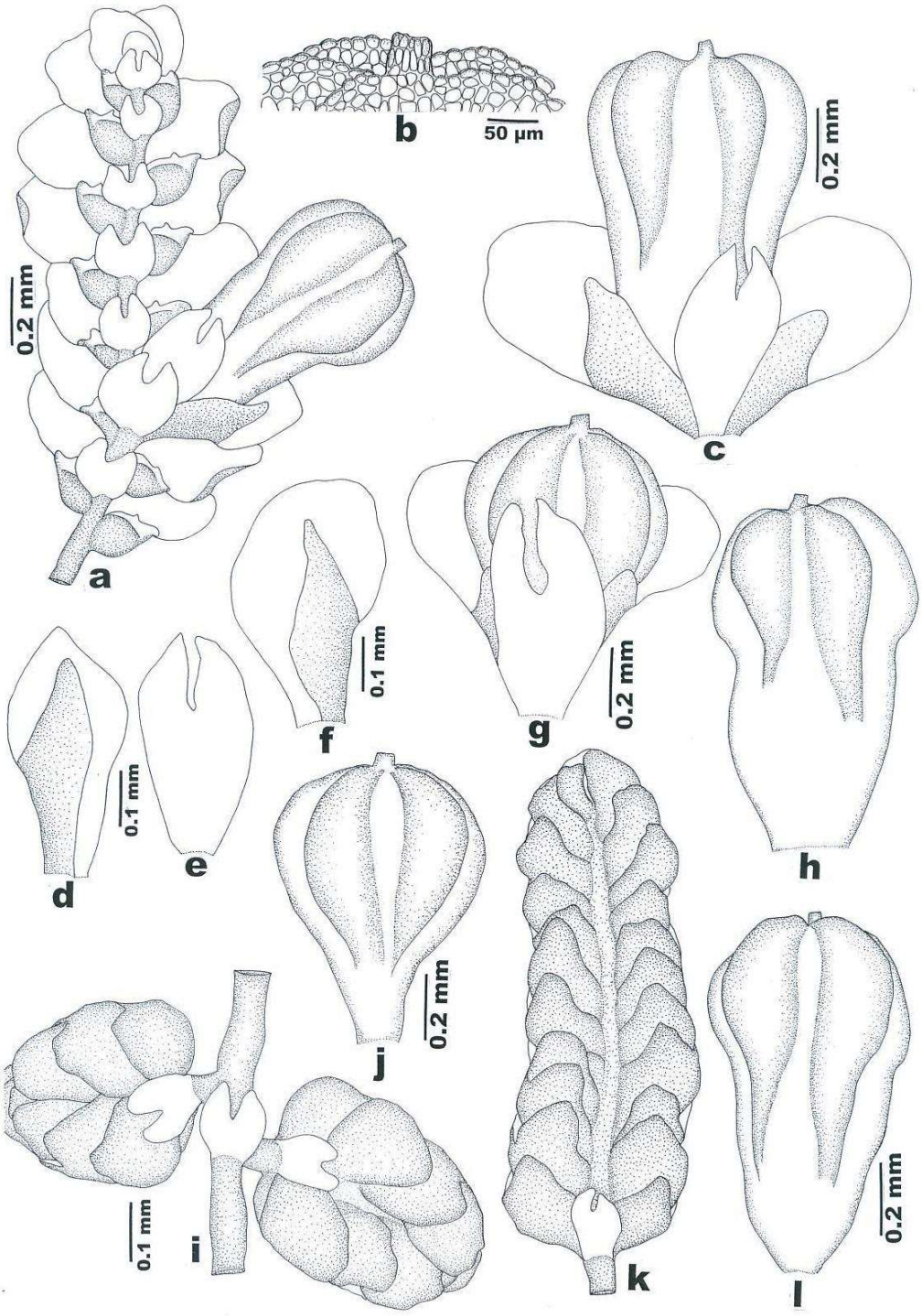

Figure 2. ***Lejeunea gradsteinii*** G.E. Lee, A. Damanhuri & A. Latiff sp. nov.: **a**: Part of plant, with perianth-bearing branch; **b**: Apical cells of perianth; **c,g**: Perianths with bracts and bracteoles; **d.f**: Female bracts; **e**: Female bracteole; **h,j,l**: Perianths; **i,k**: Androecial shoot. (All from holotype G.E. Lee 1891).

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